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STATISTICS OF THE 1918 EPIDEMIC OF INFLUENZA IN CONNECTICUT

WITH A CONSIDERATION OF THE FACTORS WHICH INFLUENCED THE
PREVALENCE OF THIS DISEASE IN VARIOUS
COMMUNITIES

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GENERAL HISTORY OF THE EPIDEMIC IN CONNECTICUT

According to the information courteously furnished to us by Dr. T. E. Reeks, epidemiologist of the State Department of Health:

"Influenza first appeared as an epidemic in Connecticut in New London, in the eastern part of the State, on or about September 1, 1918, when several cases of the disease were reported by the naval hospital at New London. These cases came primarily from the Experimental Station and Fort Trumbull where vessels from foreign ports had discharged patients. Within a day or two several cases were brought to the hospital from the submarine base located two miles above New London. About one hundred cases were sent to the New London naval hospital within the first ten days of September.

"On September 9, three cases were reported among the civilian population adjoining Fort Trumbull all of which were among employees in the Fort, and from September 12 on, a large number of cases were reported, particularly from the government station on the State pier where three hundred men from the Boston Navy Yard arrived on September 10. Nearly seven thousand of the naval men in the New London District were boarded in civilian homes, and the disease became generally prevalent among the civilians before the end of the month. The total number of cases (civilian) reported in New London for September was 901; in October, 936. No statistical data were furnished by the naval department after the first few cases.

"While the disease was primarily introduced into New London by ships arriving there from abroad and by men from the Boston Navy Yard, numerous foci developed in different parts of the State about the middle of September, the source of which was traced to other military establishments, principally Camp Devens, Mass.

"The towns early affected and in which a definite history was obtained of the disease developing two or three days following visits of soldiers from Camp Devens include Wallingford, Willimantic, Hartland, Rockville and Danbury. The wave of the infection in Connecticut was from east to west, reaching its peak in the eastern section about October 4, in the central section October 15, and in the western part of the State about October 24. These dates are based on morbidity and mortality reports from the various counties. The towns early infected by visitors from military establishments passed the climax sooner than the surrounding towns."

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The general story of the epidemic is clearly told in tables 1, 2 and 3, the data for which were obtained for us from the records of the State Department of Health through the courtesy of Mr. J. P. Balfe, Director of the Bureau of Vital Statistics of the Department. The rates, as calculated in table 2, have been presented in graphic form in figure 1. It will be noted that the increase in the death rate first became noticeable in the week ending September 21; that it rose to its height in the weeks ending October 19 and October 26, and then fell rapidly to a value only a little above normal in the week ending November 23. There were slight secondary rises in December and again in January, while by February the effects of the epidemic had entirely disappeared.

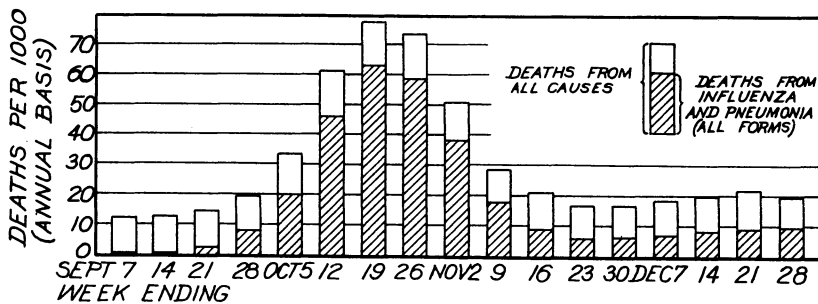


Fig. 1.—Weekly death rates in Connecticut, September to December, 1918.

EXTENT OF THE EPIDEMIC

The influenza epidemic of 1918 was by far the most serious outbreak of communicable disease from which the State of Connecticut has suffered since the beginning of its accurately recorded sanitary history. The annual death rate reported by the State Department of Health has reached 19 per 1,000 only four times since 1848. The two highest annual rates on record are both rates of 19.4 per 1,000, and these two rates are for the influenza epidemic years of 1892 and 1918.

The normal general death rate was, however, several points higher thirty years ago than today, so that the effect of the recent influenza epidemic was much more serious than was that of its predecessor during any single year.

The deaths actually reported as due to influenza and pneumonia (all forms) showed the following fluctuations during the winter months of 1918-1919.

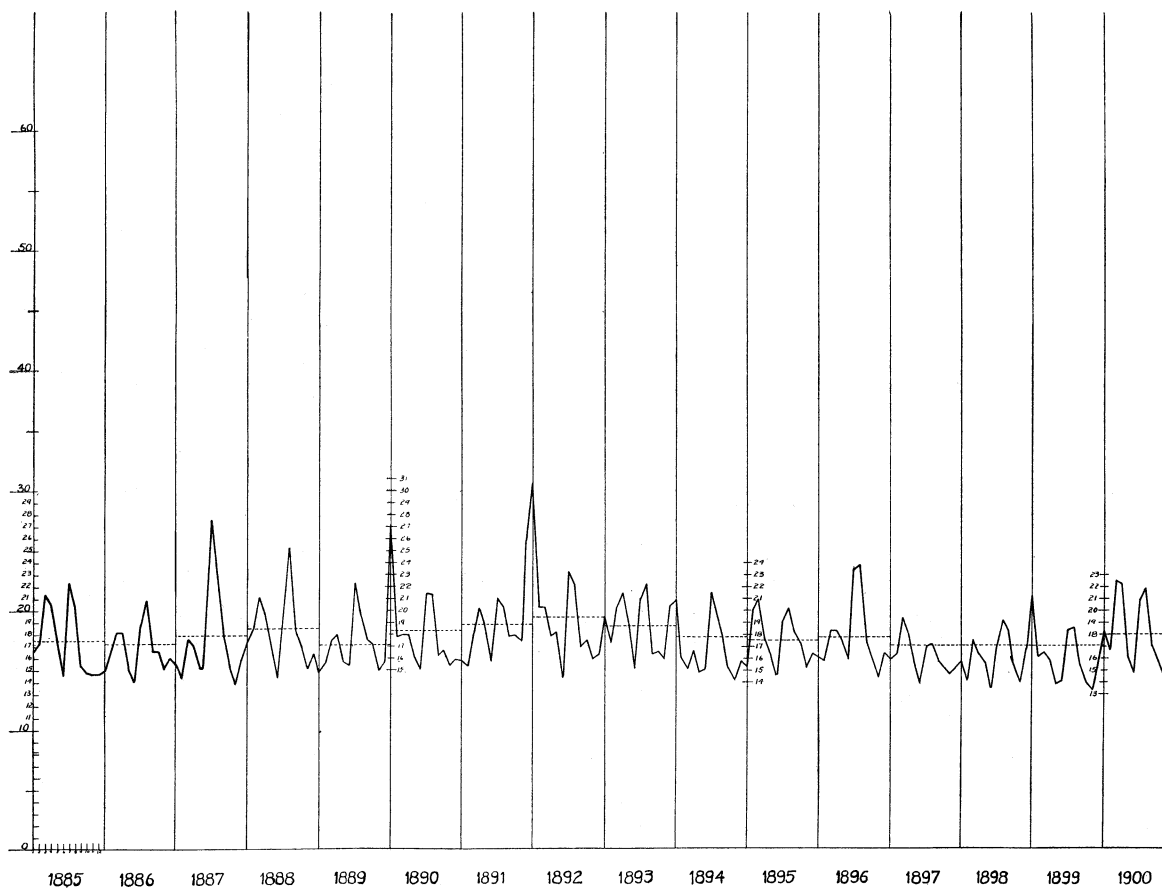
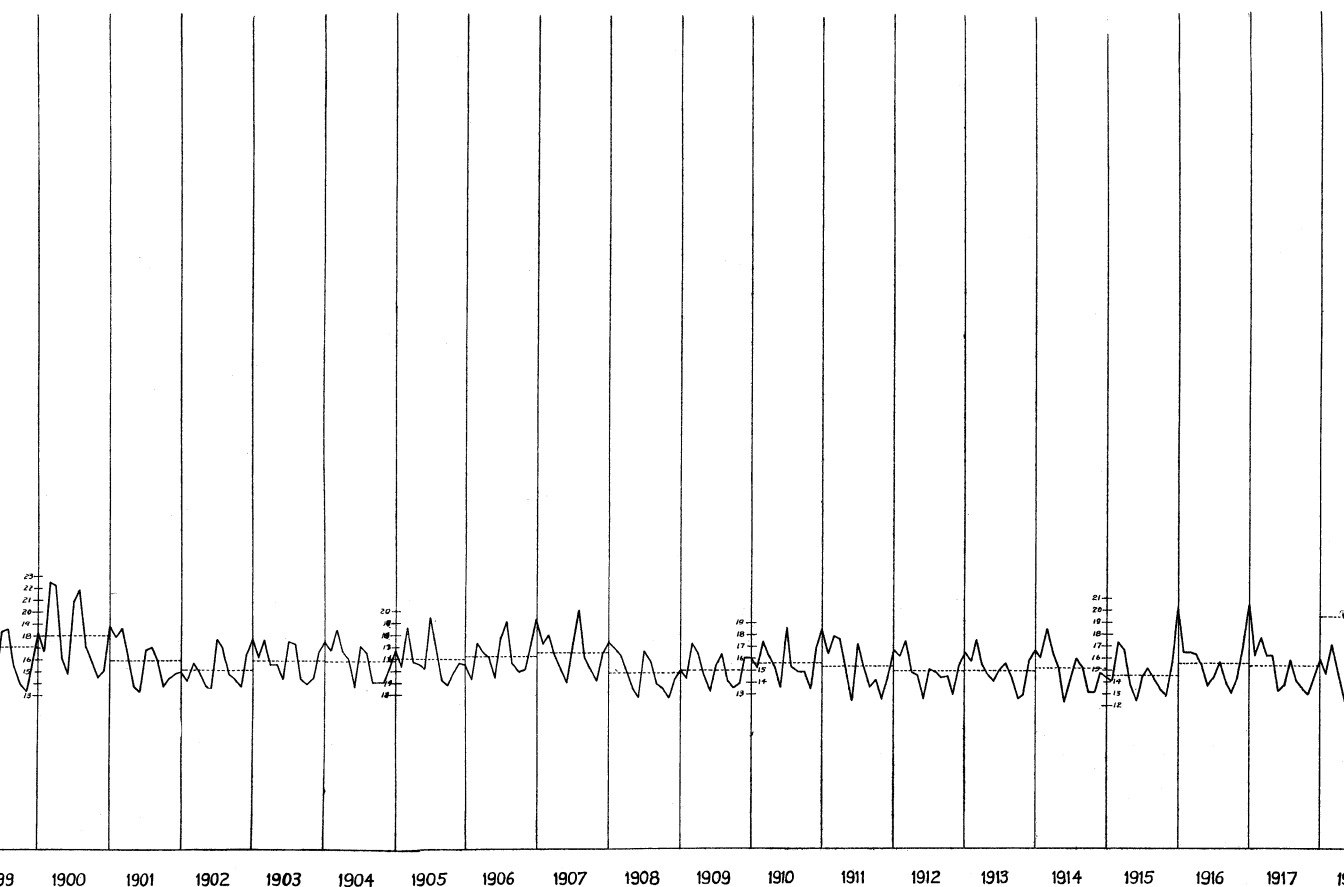
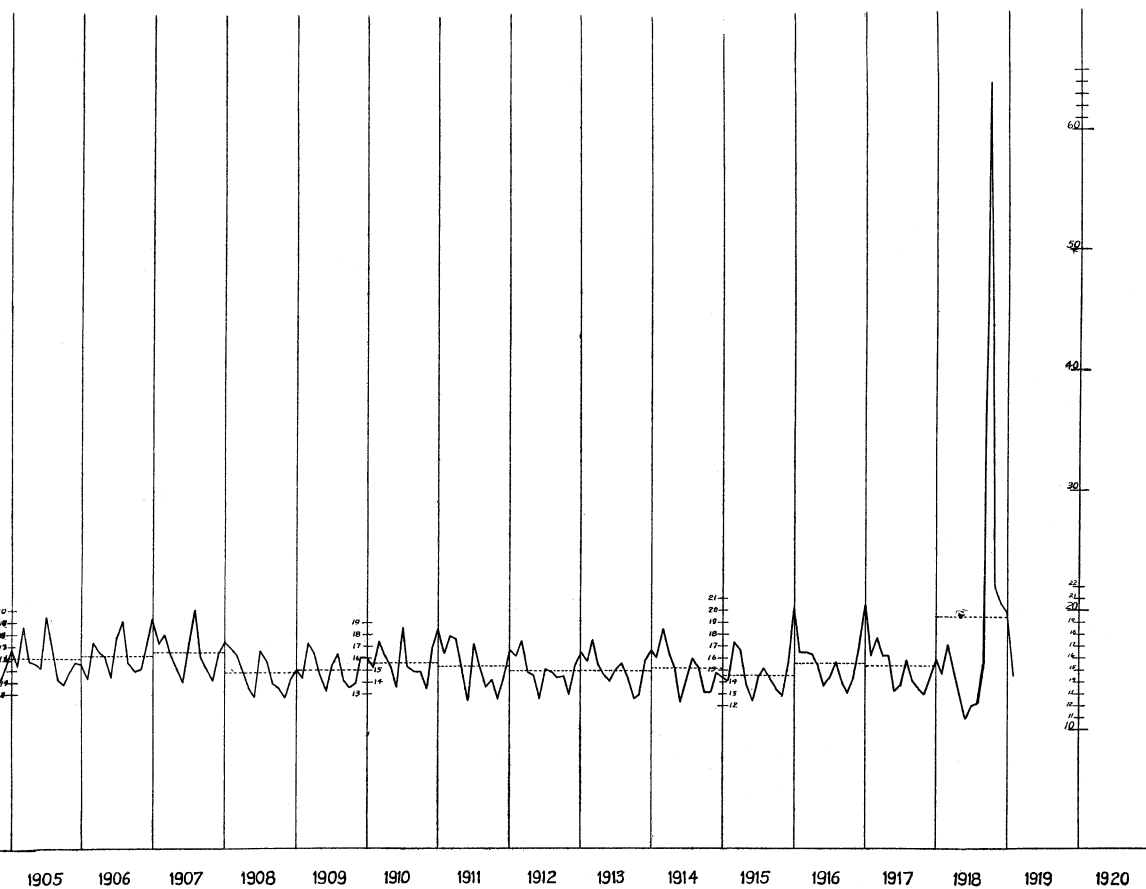


Fig. 2.—Monthly death r



ly death rate from all causes per 1,000 population in Connecticut (on annual basis).



population in Connecticut (on annual basis).

TABLE 1
DEATHS FROM INFLUENZA AND PNEUMONIA

September, 1918	445
October, 1918	5,813
November, 1918	1,297
December, 1918	1,063
January, 1919	987
February, 1919	526

This table would indicate an excess of somewhat less than 7,000 deaths from influenza and pneumonia during the four epidemic months; although it is very difficult to make any estimate of this kind on account of the wide variations in pneumonia rates from year to year. Furthermore, the fact that statements of the cause of death are hastily entered during a severe epidemic makes an analysis based on such data necessarily incomplete.

TABLE 2
DEATHS FROM ALL CAUSES BY SEX AND WEEKS FROM SEPT. 1 TO DEC. 23, 1918, WITH DEATH RATE

Week Ending	Deaths from All Causes				Deaths from Influenza and Pneumonia			
	Male	Female	Total	Death Rate†	Male	Female	Total	Death Rate†
Sept. 7	178	154	332	12.2	10	5	15	0.5
14	181	162	343	12.6	12	6	18	0.6
21	221	171	392	14.4	42	20	62	2.2
28	310	222	532	19.6	149	79	228	8.4
Oct. 5	515	396	912*	33.6	324	223	547	20.1
12	914	742	1,656	61.0	709	544	1,253	46.1
19	1,176	929	2,105	77.5	979	735	1,714	63.1
26	1,075	915	1,990	73.3	858	746	1,604	59.1
Nov. 2	735	650	1,386*	51.0	557	489	1,046	38.5
9	410	363	774*	28.5	262	224	486	17.9
16	286	285	571	21.0	121	125	246	9.0
23	256	196	452	16.6	90	76	166	6.1
30	243	212	455	16.7	92	78	170	6.2
Dec. 7	258	239	497	18.3	82	110	192	7.0
14	280	252	532	19.6	122	102	224	8.2
21	332	260	592	21.8	137	119	256	9.4
28	290	247	537	19.7	142	119	261	9.6
	7,660	6,395	14,058	30.4	4,688	3,800	8,488	18.39

* 3 sex unknown.

† Death rates figured on annual basis.

1918—State population 1,410,665.

In an outbreak of such extraordinary proportions as this one, by far the safest measure of its actual extent is the death rate from all causes, compared with a reasonable norm, and for this purpose we have used the average of corresponding months for the five preceding years. Through the courtesy of Mr. J. P. Balfe, Chief of the Bureau of Vital

Statistics of the State Department of Health, we have obtained the complete data presented in table 3 for deaths and death rates from all causes by months from January, 1885, to February, 1919, inclusive. It will be noted from this table and from figure 2 that the monthly death rate for October, 1918, reached the enormous figure of 63.9 deaths per annum per 1,000 population, a figure more than double the highest figure recorded in the earlier epidemic, a rate of 30.6 for January, 1892. It should be noted, however, that there were rates of 27.2 for January, 1890, and of 27.6 for December, 1891, so that the total death rate from the 1890-1892 influenza was greater than that which has so far resulted from the present outbreak. For a single month, however, the death toll of last October was absolutely unprecedented.

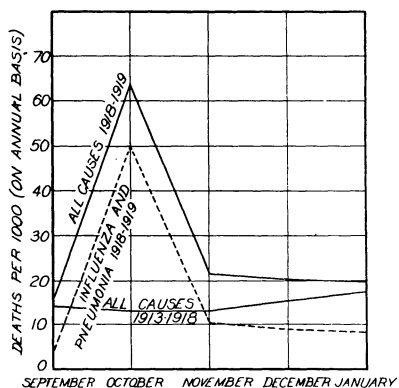


Fig. 3.—Monthly death rates in the state of Connecticut.

It will be noted from table 3 that the death rate for September, 1918, was a fairly normal one and that by February, 1919, the rate had again returned to a reasonably low figure. The death rate for October exceeded the October average for the five previous years by 51 points (see table 4), that for November exceeded its corresponding average by about 9 points, that for December exceeded its corresponding average by 5 points, and that for January its corresponding average by 2 points, a total of 67 points,—corresponding (since these are monthly death rates figured on an annual basis) to over 5.5 points for the year, indicating that the epidemic actually cost the state over 5.5 lives per 1,000 population, or over 7,700 lives.

TABLE 3
DEATHS FROM ALL CAUSES BY MONTHS, AND MONTHLY DEATH RATES FROM 1885 TO 1919, INCLUSIVE

Year	Esti- mated Popu- lation	Janu- ary		Febru- ary		March		April		May		June		July		August		Septem- ber		Octo- ber		Novem- ber		Decem- ber		Total Deaths	Year- ly Death Rate
		Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate		
1885	684,478	945	16.6	968	17.3	1,222	21.4	1,173	20.6	998	17.5	833	14.6	1,276	22.4	1,156	20.3	887	15.5	847	14.8	842	14.7	841	14.7	12,008	17.5
1886	696,835	906	15.1	980	16.3	1,060	18.2	1,083	18.2	907	15.2	835	14.0	1,120	18.8	1,240	20.8	1,004	16.7	965	16.6	963	15.1	968	16.1	12,027	17.2
1887	709,192	942	15.5	980	14.4	1,067	17.6	1,083	17.1	930	15.3	920	15.2	1,088	27.8	1,386	22.8	1,004	18.0	983	15.2	944	13.8	966	15.6	12,686	17.9
1888	729,538	1,100	17.4	1,170	18.5	1,281	21.1	1,196	19.6	1,040	17.2	876	14.3	1,088	27.8	1,525	25.4	1,083	18.3	1,033	17.2	915	15.0	1,003	16.4	13,512	18.5
1889	733,906	912	14.9	956	15.6	1,076	17.5	1,101	18.0	957	15.6	946	15.4	1,367	22.3	1,204	19.6	1,074	17.3	1,033	17.2	917	14.9	963	15.7	12,529	17.1
1890	746,258	1,698	27.2	1,107	17.8	1,119	17.9	1,124	18.0	1,005	16.1	834	15.0	1,337	21.4	1,328	21.3	1,031	16.5	1,087	16.6	957	15.3	983	15.9	13,665	18.3
1891	762,468	1,085	15.8	975	15.8	1,147	18.0	1,285	20.2	1,196	18.8	1,000	15.7	1,335	21.0	1,296	20.3	1,031	16.5	1,143	17.5	1,118	17.5	1,754	27.6	14,385	18.8
1892	778,678	1,986	30.6	1,316	20.2	1,313	20.2	1,159	17.8	1,175	18.1	929	14.3	1,506	23.2	1,440	22.1	1,102	16.9	1,141	17.5	1,087	15.9	1,062	16.3	15,170	19.4
1893	794,888	1,298	19.5	1,149	17.3	1,333	20.1	1,418	21.4	1,245	18.7	1,005	15.1	1,396	21.0	1,468	22.1	1,081	16.3	1,068	16.5	1,054	15.9	1,353	20.4	14,901	18.7
1894	811,098	1,407	20.8	1,088	16.0	1,017	15.0	1,123	16.6	1,002	14.8	1,021	15.1	1,455	21.5	1,335	19.7	1,198	17.7	1,016	15.0	967	14.3	1,067	15.7	13,699	16.8
1895	827,308	1,059	15.3	1,380	20.0	1,443	20.9	1,220	17.6	1,122	16.2	986	14.3	1,320	19.1	1,387	20.1	1,251	18.1	1,192	17.2	1,053	15.2	1,131	16.4	14,546	17.5
1896	843,518	1,129	16.0	1,114	15.8	1,293	18.3	1,280	17.4	1,121	15.9	1,042	13.8	1,642	23.3	1,675	23.8	1,225	17.4	1,121	16.0	1,015	14.4	1,159	16.4	15,025	17.8
1897	858,728	1,142	15.9	1,173	16.3	1,393	19.4	1,219	17.0	1,138	15.8	998	13.9	1,223	17.0	1,239	17.2	1,146	15.9	1,097	15.3	1,054	14.7	1,090	15.2	13,915	16.1
1898	875,938	1,159	15.8	1,065	14.1	1,280	17.5	1,197	16.4	1,139	15.6	983	13.4	1,230	16.8	1,407	19.2	1,355	18.4	1,123	15.3	1,029	14.0	1,231	16.8	14,170	16.1
1899	892,148	1,577	21.2	1,197	16.1	1,229	16.5	1,175	15.8	1,031	13.8	1,053	14.1	1,374	18.4	1,387	18.6	1,145	15.4	1,040	13.9	990	13.3	1,174	15.7	14,381	16.1
1900	908,355	1,367	18.2	1,265	16.7	1,698	22.4	1,684	22.2	1,231	16.2	1,126	14.8	1,587	20.9	1,652	21.8	1,291	17.0	1,210	15.9	1,100	14.5	1,140	13.0	16,368	18.0
1901	929,430	1,456	18.7	1,387	17.9	1,444	18.6	1,261	16.2	1,067	13.7	1,032	13.3	1,304	16.8	1,319	17.0	1,239	15.9	1,065	13.7	1,113	14.4	1,149	14.8	14,852	15.9
1902	950,506	1,182	14.9	1,328	14.2	1,251	15.7	1,195	15.0	1,100	13.8	1,065	13.4	1,416	17.7	1,349	17.3	1,165	14.7	1,138	14.3	1,089	13.7	1,301	16.4	14,386	15.1
1903	971,581	1,427	17.6	1,304	16.1	1,423	17.5	1,261	15.5	1,268	15.6	1,166	14.4	1,416	17.0	1,365	16.5	1,163	14.0	1,126	13.9	1,172	14.4	1,350	16.6	15,490	15.9
1904	992,657	1,445	17.4	1,367	16.7	1,524	18.4	1,379	16.6	1,317	15.9	1,127	13.6	1,416	17.0	1,365	16.5	1,163	14.0	1,126	13.9	1,172	14.4	1,350	16.6	15,490	15.9
1905	1,013,732	1,412	16.7	1,367	16.3	1,576	18.6	1,329	15.7	1,300	15.5	1,239	15.2	1,653	19.5	1,416	16.7	1,200	14.2	1,166	13.8	1,258	14.8	1,322	15.6	16,298	16.0
1906	1,034,808	1,344	15.5	1,236	14.3	1,480	17.2	1,430	16.5	1,403	16.2	1,248	14.4	1,518	17.8	1,761	20.0	1,409	16.0	1,335	15.1	1,244	14.1	1,450	16.4	17,490	16.5
1907	1,055,883	1,696	19.2	1,519	17.2	1,578	17.9	1,419	16.1	1,329	15.1	1,226	13.9	1,496	16.6	1,410	15.7	1,240	13.8	1,215	13.5	1,144	12.7	1,280	14.2	16,400	14.8
1908	1,076,959	1,557	17.3	1,515	16.8	1,456	16.2	1,330	14.8	1,304	13.4	1,146	12.7	1,416	15.4	1,492	16.3	1,293	14.1	1,237	13.5	1,266	13.8	1,467	16.0	16,484	15.0
1909	1,098,034	1,367	14.9	1,313	14.3	1,575	17.2	1,508	16.4	1,232	14.5	1,214	13.2	1,416	15.4	1,492	16.3	1,293	14.1	1,237	13.5	1,266	13.8	1,467	16.0	16,484	15.0
1910	1,119,110	1,498	16.0	1,421	15.2	1,632	17.4	1,505	16.1	1,421	15.2	1,296	13.5	1,735	18.6	1,426	15.2	1,387	14.8	1,381	14.8	1,252	13.4	1,575	16.8	17,504	15.6
1911	1,140,004	1,760	18.5	1,556	16.3	1,692	17.8	1,679	17.6	1,435	15.1	1,213	12.5	1,454	15.0	1,433	14.8	1,391	14.3	1,397	14.1	1,256	12.9	1,489	15.3	17,554	15.3
1912	1,160,868	1,600	16.5	1,567	16.1	1,681	17.3	1,428	14.7	1,406	14.4	1,213	12.5	1,498	15.1	1,535	15.5	1,422	14.4	1,239	12.5	1,275	12.9	1,549	15.7	17,722	14.9
1913	1,181,793	1,614	16.3	1,547	15.7	1,704	17.3	1,507	15.3	1,424	14.4	1,408	14.2	1,498	14.3	1,566	15.9	1,479	14.2	1,388	13.4	1,327	12.8	1,615	15.6	18,083	14.5
1914	1,202,688	1,671	16.6	1,623	16.1	1,845	18.4	1,650	16.4	1,509	15.4	1,233	12.3	1,499	14.4	1,566	15.1	1,526	15.2	1,409	13.9	1,354	12.9	1,589	14.2	20,142	15.3
1915	1,241,314	1,502	14.5	1,450	14.0	1,783	17.2	1,720	16.6	1,411	13.6	1,290	12.4	1,489	14.4	1,685	15.6	1,585	14.0	1,517	13.4	1,459	12.9	1,610	14.2	20,746	15.3
1916	1,291,989	2,170	20.1	1,769	16.4	1,773	16.4	1,765	16.3	1,664	14.4	1,473	13.6	1,553	13.7	1,792	15.8	1,585	14.0	1,409	13.4	1,327	12.8	1,615	15.6	20,142	15.3
1917	1,354,930	2,305	20.4	1,818	16.4	1,964	17.6	1,822	16.1	1,820	16.1	1,496	13.2	1,553	13.7	1,792	15.8	1,585	14.0	1,409	13.4	1,327	12.8	1,610	14.2	20,746	15.3
1918	1,410,665	1,877	15.9	1,717	14.6	2,010	17.0	1,834	15.6	1,489	12.6	1,273	10.8	1,418	12.0	1,431	12.1	1,818	15.4	7,516	63.9	2,566	21.8	2,421	-20.5	27,378	19.4
1919	1,464,360	2,425	19.8	1,766	14.4																						

1885-1914 inclusive, population figured on U. S. census method. 1915-1919 inclusive, population figured on school population.

TABLE 4
DEATH RATES, 1913 TO 1918

	Average Death Rate from All Causes*		Excess for 1918-19	Death Rate from Influenza and Pneumonia* 1918-1919
	1913-1918	1918-1919		
September.....	14.3	15.4	1.1	8.7
October.....	13.1	63.9	50.8	50.0
November.....	13.2	21.8	8.6	10.4
December.....	15.4	20.5	5.1	9.0
January.....	17.5	19.8	2.3	8.4

* Death rates per 1,000 population on an annual basis.

These cold figures present but a faint picture of the actual extent of the tragedy. We must go back to records of bubonic plague to find a parallel for the conditions which existed in many Connecticut communities during the height of the epidemic. Emergency hospitals were improvised, 35 of them being established, supervised or assisted by the State Department of Health, and 100 nurses and 48 physicians, largely supplied by the U. S. Public Health Service, were sent to the places in greatest need. Yet as physicians and nurses were themselves stricken down by the epidemic, the lack of medical and nursing care was in many cases acute. Many persons died without any medical attention, and there were not a few instances of whole families being wiped out within a few days. In the cities most severely affected the great problem came to be the burial of the dead. At Waterbury and New Britain, for example, coffins remained for days on the ground, until in the latter case the mayor assigned the engineering force of the city to the task of digging graves.

MORBIDITY AND FATALITY RATES

Influenza was declared a reportable disease by the State Department of Health in New London on September 12 and throughout the State on September 18. The reporting was of course, however, exceedingly incomplete in face of the tremendous emergency faced by physicians during the epidemic. The actual number of cases of influenza and pneumonia (all forms) reported by months with the corresponding deaths and fatality rates are indicated in table 5.

The fatality figures are, of course, extravagantly high, due to incomplete case reports, particularly during the last three months.

A somewhat better idea of actual conditions may be gained from the excellent records of the Visiting Nurse Association of New Haven, courteously placed at our disposal by Miss Mary G. Hills, the superin-

tendent of the Association, and analyzed by Mr. David Greenberg, instructor in the department of public health of the Yale School of Medicine. Seven hundred and thirty-six cases of influenza and pneumonia were cared for during the epidemic with 32 known deaths, giving a fatality rate of 4.3 deaths per 100 cases. Even this rate is certainly too high, since many light cases failed to receive nursing care.

TABLE 5
REPORTED MORBIDITY AND FATALITY, INFLUENZA AND PNEUMONIA, STATE OF CONNECTICUT

	Reported Cases	Deaths	Deaths per 100 Cases
September, 1918.....	7,864	432	5
October, 1918.....	92,698	5,895	6
November, 1918.....	6,244	1,297	21
December, 1918.....	8,043	1,063	13
January, 1919.....	6,804	987	15

The only way in which really complete data can be obtained in regard to morbidity and fatality from influenza is by detailed house to house canvasses, and a number of surveys of this sort were conducted by the State Department of Health. Dr. T. E. Reeks has supplied us with the following information in regard to one such study conducted in New Britain. Between December 3 and 6, 145 dwellings were visited in which there had been 2,757 persons. Of this number, 645 had had influenza and 25 had died. These figures would indicate a morbidity rate of 234 per 1,000 and a fatality rate of 3.9 deaths per 100 cases.

It seems probable that even in this instance the information obtained was incomplete in regard to light cases. Surveys conducted by the New York State Department of Health, reported by G. W. Baker,¹ and other studies made by the U. S. Public Health Service in selected districts of Maryland² indicate for a combined population of nearly 80,000 persons, a morbidity rate of 311 per 1,000, a mortality rate of 7.1 per 1,000, and a fatality rate of 2.3 deaths per 100 cases. We may perhaps safely conclude that the proportion of the population actually affected by the influenza epidemic varied between 200 and 400 per 1,000, and that the actual fatality rate was somewhere between 2 and 4 deaths per 100 cases, the higher morbidity rate and the lower fatality rate being more likely to be correct.

¹ Official Bulletin, New York State Department of Health, May 1, 1919, 4, V. S. No. 5.

² Public Health Reports, March 14, 1919.

EPIDEMIOLOGY

The first outstanding fact in regard to the epidemiology of the disease was the tremendous rapidity with which it spread throughout the state. Assuming that the epidemic was limited to the five months of September, 1918, to January, 1919, inclusive, we have calculated for each county the median day of the outbreak; that is, the day on which the first half of the total of reported deaths was reached. For New London County the median day was October 12; for Windham County, October 13; for Tolland County, October 21; for Middlesex and New Haven counties, October 22; for Hartford County, October 23, and for Fairfield and Litchfield counties, October 29 (Fig. 4).

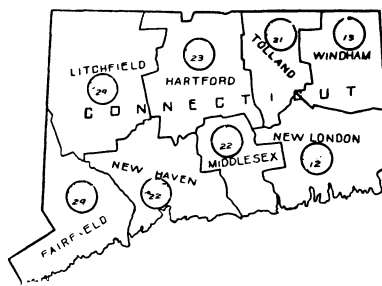


Fig. 4.—Median day of influenza epidemic in each county of Connecticut. Figures represent dates in October.

The outbreak, starting in the southeastern region of the state, passed north and then west, reaching its crest in New Haven and Hartford about ten days later than in New London, and in Fairfield County about a week later than in New Haven.

It seems very clear that a disease which spreads throughout a whole state within one month and ultimately affects from 20 to 40% of its population, must be a communicable disease of an exceedingly acute and readily transmissible type. One condition and one condition only temporarily checked the spread of the infection—complete institutional quarantine. There were many instances in Connecticut of schools, asylums, prisons and other institutions which maintained absolute quarantine and escaped infection, while it was raging all about them,—in every instance, so far as we are aware, to experience a normal incidence at a later date when the quarantine was lifted or accidentally broken.

One excellent illustration was furnished by an orphan asylum in New Haven, which completely escaped during the month of October when the epidemic was at its height in the city. One of the sisters and the priest in charge came down with influenza about December 15. On December 27, 127 cases occurred in the institution within 24 hours, and by January 7 there had been 424 cases with 7 deaths out of a total population of 464 persons. The most probable source of the sharp outbreak on December 27 seemed to be the sister first affected, who, on convalescence, resumed her duties in the kitchen, which included the inspection and handling of the milk served to the children.

This particular institutional outbreak might well have been due to food infection or transmission by eating utensils such as has been described in army camps by Drs. Lynch and Cumming.³ In general, however, it seems clear that neither food nor insect transmission, under the general sanitary conditions of American life, can account for the spread of an epidemic on such a scale and at such a rate as that which characterized the influenza epidemic of October, 1918, as a whole. Direct contact transmission must certainly be looked on as the chief agent in such an outbreak.

The rapidity of the spread of the infection would also suggest an exceedingly short period of incubation, and we have ample evidence in individual cases that the incubation period for this disease is ordinarily close to 48 hours.

Further conclusions in regard to epidemiology can be formulated with much less certainty. In observing the spread of the disease through local population groups, we were at first inclined to believe that the usual source of infection was an early case, generally recognizable as suffering from some sort of respiratory infection. If this conclusion were justified, the problem, as in the case of measles, would be to isolate all contacts exhibiting any abnormal conditions; and control, though difficult, would not be impossible. Later experience has raised doubts as to the possible part played by convalescents and well carriers. In the case of the orphan asylum cited above, for example, the original infection appeared to come from a convalescent rather than an early case. Until we are certain as to the part played by well carriers, by incipient cases, by frank cases, and by convalescents, as sources, and until we can gauge the relative importance of mouth spray, hand contact, fomites, food and other possible vehicles of infection, it will be extremely difficult to formulate an intelligent policy of control. In any case, as we shall point out below in connection with the variations in the local incidence of the disease, there is no evidence that any method of control except absolute institutional quarantine had any influence upon its spread in the state of Connecticut.

³ Amer. Jour. of Public Health, 1919, 9, p. 25.

AGE AND SEX AS PREDISPOSING FACTORS IN THE EPIDEMIC

One of the most striking features of the 1918 epidemic of influenza was the characteristic age incidence of the disease. All over the world, so far as we have seen reports of the outbreak, it displayed a marked predilection for the years of young adult life and passed lightly by the later age periods.

On account of the long period which has elapsed since the census of 1910, there are no accurate data available for the calculation of actual death rates on a large scale. The general age incidence of the epidemic can be easily brought out, however, by the calculation of ratios; and for this purpose we obtained from Mr. Balfe the number of deaths from all causes and from influenza and pneumonia classified by months for the four last months of 1918, and to furnish a basis of

TABLE 6
TOTAL NUMBER OF DEATHS FOR EACH MONTH

	Deaths from All Causes		Deaths from Influenza and Pneumonia 1918
	1917	1918	
September.....	1,585	1,818	445
October.....	1,517	7,516	5,813
November.....	1,459	2,566	1,297
December.....	1,442	2,158	933

TABLE 7
PERCENTAGE OF DEATHS OCCURRING AT EACH AGE PERIOD

	Age											
	-1	1-4	5-9	10-14	15-19	20-24	25-29	30-39	40-49	50-59	60-69	70+
All Causes 1917:												
September.....	23	9	2	1	2	3	3	8	8	10	13	18
October.....	18	6	2	2	2	3	2	9	10	11	15	20
November.....	15	5	2	1	1	4	4	7	11	13	14	23
December.....	16	7	3	1	2	3	4	7	9	11	14	23
Average.....	18	7	2	1	2	3	3	8	10	11	14	21
All Causes 1918:												
September.....	19	6	2	2	3	5	7	11	10	9	10	16
October.....	8	9	3	2	5	10	16	23	9	5	5	5
November.....	12	8	3	2	3	6	11	17	9	9	7	13
December.....	12	6	3	2	3	5	9	15	9	9	11	16
Average.....	11	8	3	2	4	8	13	19	9	7	6	10
Influenza and Pneu- monia, 1918:												
September.....	6	6	2	2	5	12	19	26	10	5	4	3
October.....	5	10	3	2	5	12	19	27	9	4	2	1
November.....	7	12	3	3	4	10	18	25	8	5	3	3
December.....	8	7	3	3	5	8	15	24	9	6	5	6
Average.....	6	10	3	3	5	11	19	26	9	4	3	2

comparison, the deaths from all causes for the corresponding months of 1917. The total number of deaths for each month used in this analysis are presented in table 6, and the percentage distribution by age periods in table 7.

The four last months of 1917 show a normal age distribution, with one quarter of all deaths occurring under 5 years of age, one quarter between 5 and 40 years, and half over 40 years, the proportion of infant deaths decreasing and the proportion of deaths in old age increasing as one passes from the season of intestinal disturbances to the season of respiratory diseases.

In 1918 the distribution of deaths from all causes is strikingly different. Instead of less than a quarter of all deaths occurring between the ages of 5 and 40 years, this period included 49% of all deaths in 1918; and the two decades between 20 and 40 included 40% of all deaths (as against only 14% in 1917).

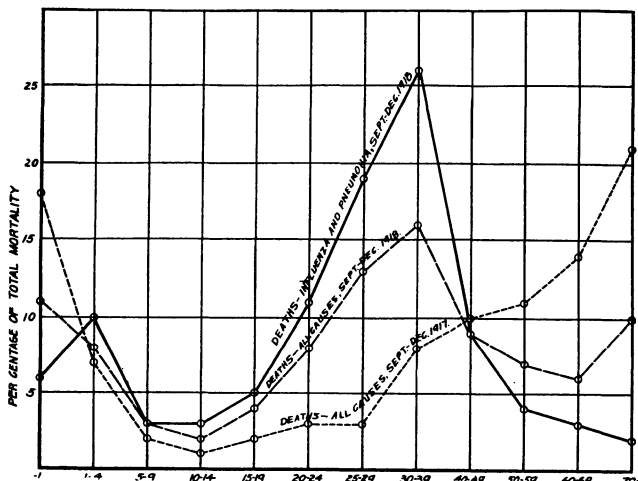


Fig. 5.—Age distribution of deaths from the influenza epidemic compared with normal.

Considering influenza and pneumonia alone, these two decades included 56% of the deaths, while only 9% occurred at ages over 49. The decade between 20 and 29 was most severely affected, including 30% of all deaths, while the decade between 30 and 39 was a close second with 26%.

An even higher incidence occurred at ages under 5 years, as has been brought out in other investigations,⁴ since this age period con-

⁴ Notably the summary presented by G. W. Baker, Official Bull., N. Y. State Depart. of Health, Vol. 4, V. S. No. 5.

tributed 16% of all the influenza-pneumonia deaths. The proportion of deaths from all causes in infancy did not rise even to normal, but with the enormous rise in total deaths the maintenance of a nearly normal ratio, of course, means a heavy influenza mortality.

Whether the high death rate under 5 years and between 20 and 40 years of age was due to an actually excessive incidence of influenza or merely to a higher fatality can only be determined by house to house surveys, since case reports during the outbreak were almost valueless. Frost⁵ reports that a series of such intensive studies indicate that the actual case incidence of the disease was highest at ages 5-14 and uniformly decreased in later age periods.

It has been the tendency of some writers to assume that the relatively low mortality among those past middle life was due to artificial immunity acquired in the preceding epidemic of 1890-92. This seems to us somewhat doubtful. If such acquired immunity were the cause of the age distribution of influenza mortality, the drop should presumably have come at 30 years, while as a matter of fact the rate for the decade 30-40 was practically the same as that for the preceding one.

From the standpoint of sex, the Connecticut figures, as has been the case in other localities, show a distinctly heavier mortality among males. Of the influenza-pneumonia deaths in the last four months of 1918, 58% were among males. Two possible factors in producing such a condition suggest themselves,—greater exposure to the original infection and greater tendency to keep up and about when ill, which is one of the common factors in contributing to serious pneumonias. According to the Baker study referred to above, the latter would seem to be the more important, since in his surveys the incidence rate was alike for both sexes, but the fatality materially higher among males.

Frankel and Dublin⁶ point out that an excessive death rate among males is characteristic of pneumonia and that the excess in the influenza-pneumonia of 1918 was rather less than the normal male excess for this disease.

RACE AS A PREDISPOSING FACTOR IN THE EPIDEMIC

The fundamental data presented in table 6 have been analyzed from the standpoint of the mother-nativity of the decedents, and the results are presented below in table 8 and in figure 6.

⁵ Public Health Reports for Aug. 15, 1919.

⁶ A. J. P. H., 1919 9, 731.

TABLE 8
DISTRIBUTION OF DEATHS BY MOTHER NATIVITY
PERCENTAGE IN EACH GROUP

	Birthplace of Mother											
	U. S.	Ire-land	Italy	Rus-sia	Aus-tria	Ger-many	Eng-land	Can-ada	Pol-land	Rus-sian Pol-land	Other Coun-tries	Un-known
All Causes 1917:												
September.....	33	14	10	6	6	3	3	2	2	2	6	13
October.....	31	17	8	7	5	5	4	3	1	2	4	13
November.....	33	17	9	6	5	5	3	2	1	1	5	13
December.....	32	16	8	5	6	5	3	4	1	1	6	13
Average.....	32	16	9	6	6	5	3	3	1	1	5	13
All Causes 1918:												
September.....	32	13	9	8	6	3	3	4	2	2	5	13
October.....	24	11	18	10	7	3	2	4	2	3	5	11
November.....	30	13	14	6	7	4	3	2	1	2	6	12
December.....	36	14	8	6	6	4	3	3	1	1	7	11
Average.....	28	12	15	8	7	3	2	4	2	2	5	12
Influenza and Pneu- monia, 1918												
September.....	24	9	12	10	7	2	3	7	4	1	7	14
October.....	21	10	21	11	7	3	2	4	2	3	5	10
November.....	26	9	20	8	9	3	3	2	2	2	7	9
December.....	39	12	10	5	8	4	3	3	1	1	8	8
Average.....	24	10	19	9	8	3	2	4	2	2	6	10

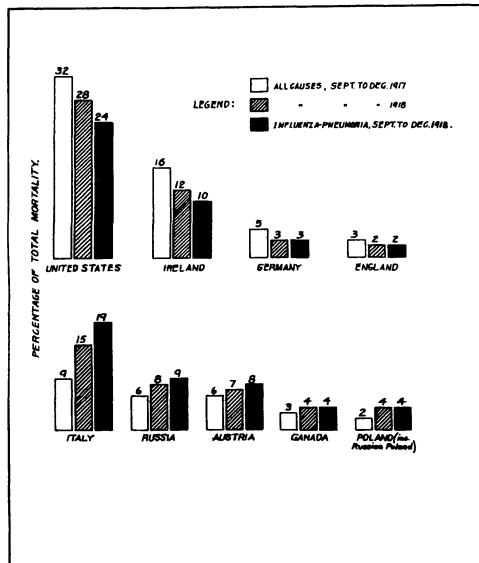


Fig. 6.—Distribution of deaths in Connecticut by mother nativity.

It appears evident that race (or some conditions associated with race) played a very large part in determining the incidence of mortality. The four months of 1917 and September, 1918, show closely concordant distributions by mother nativity; but with the onset of the epidemic marked divergences manifest themselves.

The proportion of influenza-pneumonia deaths is lower than would be expected among persons of native, Irish, English and German stock, higher than would be expected among Russian, Austrian, Canadian and Polish stock, and enormously high among Italians.

TABLE 9
DISTRIBUTION BY NATIVITY OF TOTAL CASES, TUBERCULOSIS CASES AND INFLUENZA CASES
CARED FOR BY THE V. N. A. OF NEW HAVEN, SEPTEMBER-NOVEMBER, 1918

Race	Percentage of Total Cases Cared for by V. N. A.	Cases of Influenza		Cases of Tuberculosis	
		Number	Percentage	Number	Percentage
Native.....	24.3	160	21.8	102	29.6
Native, Austrian parentage.....	1.6	9	1.2	6	1.7
Native, English-Scotch parentage...	0.9	8	1.1	1	1.7
Native, German parentage.....	0.9	10	1.4	1	0.3
Native, Irish parentage.....	4.7	30	2.7	48	13.9
Native, Italian parentage.....	23.3	183	24.9	46	13.3
Native, Russian parentage.....	12.2	83	11.3	17	4.9
Austrian.....	1.4	12	1.6	2	0.6
English.....	1.1	12	1.6	3	0.9
Irish.....	3.2	18	2.5	18	5.2
Italian.....	9.5	99	13.5	31	9.0
German.....	0.8	6	0.8	2	0.6
Russian.....	9.7	76	10.4	31	9.0
Swedish.....	0.7	6	0.8	5	1.5
Colored.....	...	6	0.8	...	...
Unknown.....	5.7	28	3.5	26	7.6
Total.....	100.0	736	100.0	345	100.0

It seems probable, as suggested by Dr. L. I. Dublin in personal discussions, that this marked difference in racial incidence is very largely due to the differences in age distribution of the various race-stocks, the races showing the highest ratios being those which have arrived more recently in the country and which are made up more largely of young adults at the ages which suffer most severely from influenza.

In part, too, this relation may be explained on the ground of differing economic status, the race-stocks disproportionately affected with influenza being those that are likely to live in the most crowded quarters of the community and under most generally unfavorable environmental conditions. The excess of the disease among the Italians is so enormous as to seem to call for some special explanation. Dr. D. B.

Armstrong⁷ has pointed out an apparent inverse relation between racial susceptibility to chronic and acute respiratory disorders, the Irish suffering heavily from tuberculosis and lightly from influenza and pneumonia, while the reverse is true of the Italians. Our results for the state of Connecticut tend to confirm his conclusions in regard to the Italians, as do the figures presented in table 9 prepared by Mr. David Greenberg from the records of the Visiting Nurse Association of New Haven. It appears that Italy suffered very severely from the influenza epidemic in Europe, and Dublin has shown that the normal pneumonia rate of this race is a very high one.

GENERAL GEOGRAPHICAL VARIATIONS IN THE SEVERITY OF THE EPIDEMIC

In discussing variations in the severity of the epidemic in different parts of the state, we have thought it best to utilize the total death rate from all causes for the months from September to December, 1918,

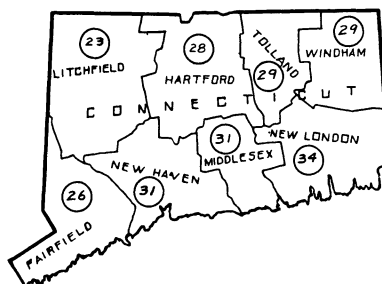


Fig. 7.—Severity of influenza epidemic by counties. Average death rate from all causes, September to December, 1918, on annual basis; deaths per 1,000.

inclusive. Actual variations in influenza-pneumonia are of course somewhat masked by the normal death rate from other causes, but in view of the errors in reporting causes of death we have felt this to be the safest course. Our figures are computed on an annual basis, the total number of deaths per 1,000 of population being multiplied by three (since the period included one third of a year). The rate for the entire state on this basis is 29.

The different counties of the state show slight but significant differences when computed in this manner. The figures are as follows: New London, 34; Middlesex, 31; New Haven, 31; Windham, 29; Tolland, 29; Hartford, 28; Fairfield, 26; Litchfield, 23.

⁷ Boston Med. and Surg. Jour., 1919, 180, p. 65.

TABLE 10
DEATHS FROM ALL CAUSES, SEPTEMBER 1 TO DECEMBER 28, BY COUNTIES

	September				October				November					December				Total	Per 1,000
	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28		
Middlesex:																			
Large towns..	14	9	11	13	22	49	60	46	26	24	20	18	10	15	18	24	15	394	39.4
Small towns..	6	5	5	12	7	13	24	21	9	10	10	2	8	6	9	7	13	167	18.6
Total.....	20	14	16	25	29	62	84	67	35	34	30	20	18	21	27	31	28	561	31.2
Tolland:																			
Large towns..	1	9	5	4	8	19	27	15	12	4	3	2	5	3	4	11	3	135	27.0
Small towns..	7	5	6	3	15	25	21	8	11	10	....	2	3	6	8	10	12	152	30.4
Total.....	8	14	11	7	23	44	48	23	23	14	3	4	8	9	12	21	15	287	28.7
Hartford:																			
Large towns..	66	79	79	105	177	368	502	429	269	132	98	86	93	102	110	109	107	2,906	29.7
Small towns..	8	12	11	12	20	38	46	43	32	22	12	15	8	16	17	13	12	337	19.6
Total.....	74	91	90	117	197	406	548	472	301	154	105	101	101	118	127	122	119	3,243	28.2
New Haven:																			
Large towns..	103	98	98	117	219	530	770	696	470	225	158	123	119	148	149	172	150	4,340	31.4
Small towns..	4	1	6	4	10	21	22	19	21	8	11	7	5	6	10	9	8	172	21.6
Total.....	107	94	104	121	229	551	792	715	491	233	169	130	124	154	159	181	158	4,512	30.8
New London:																			
Large towns..	21	24	47	95	159	157	85	46	26	31	32	28	30	31	26	42	35	915	35.2
Small towns..	14	7	16	24	41	55	41	18	13	8	15	11	11	5	12	8	13	312	31.2
Total.....	35	31	63	119	200	212	126	64	39	39	47	39	41	36	38	50	48	1,227	34.1
Fairfield:																			
Large towns..	62	61	67	84	135	206	316	481	390	234	165	110	116	120	109	124	112	2,892	26.4
Small towns..	6	4	5	11	7	12	17	19	13	10	8	7	10	7	7	5	10	158	17.6
Total.....	68	65	72	95	142	218	333	500	403	244	173	117	126	127	116	129	122	3,050	26.1
Windham:																			
Large towns..	2	7	16	29	57	92	65	33	25	12	13	14	9	5	13	14	16	422	32.4
Small towns..	4	4	2	4	2	13	10	12	7	4	4	4	8	5	6	6	5	100	20.0
Total.....	6	11	18	33	59	105	75	45	32	16	17	18	17	10	19	20	21	522	29.0
Litchfield:																			
Large towns..	9	13	7	9	19	31	77	73	45	28	17	18	12	16	20	22	16	432	25.4
Small towns..	5	10	11	6	14	27	31	17	12	10	5	8	8	6	14	16	10	224	20.4
Total.....	14	23	18	15	33	58	99	104	62	40	27	23	20	22	34	38	26	656	23.4

As indicated by figure 7 (which may be compared with figure 4), it is evident that the outbreak was most severe in the eastern counties where it broke out first, and that it decreased progressively in severity as it passed to the western and northwestern sections of the state.

It would seem probable that there was a gradual decrease either in the communicability of the disease or in its virulence after the great severity which characterized it at the time of its first invasion of New London.

1918 EPIDEMIC OF INFLUENZA IN CONNECTICUT

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TABLE 11

DEATHS, ALL CAUSES, BY LARGER TOWNS AND BY WEEKS, SEPTEMBER 1 TO DECEMBER 28

Towns	September				October				November					December				To- tal	Per 1,000
	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28		
Ansonia.....	2	1	3	16	21	33	32	16	11	6	...	4	6	1	6	9	10	177	30.6
Berlin.....	2	1	...	3	...	3	4	5	6	1	1	2	1	1	1	2	2	35	13.4
Branford.....	2	...	1	1	2	2	6	5	11	10	7	3	2	1	1	1	2	57	23.7
Bridgeport.....	28	33	28	40	45	78	135	245	232	125	91	61	64	50	51	57	54	1,417	26.2
Bristol.....	4	4	2	3	7	36	38	33	11	7	4	2	5	4	7	4	2	173	26.2
Danbury.....	3	10	10	8	18	24	32	42	27	15	9	6	8	13	7	17	5	254	27.0
Darien.....	1	...	1	...	...	2	2	5	7	2	2	1	...	1	...	5	1	30	10.3
Derby.....	2	8	9	5	19	52	36	16	13	3	2	5	3	4	4	5	5	191	56.2
East Hartford.....	...	3	1	5	1	8	7	11	5	3	3	4	2	4	2	3	1	63	16.6
Enfield.....	2	2	4	3	3	9	20	15	19	6	3	1	4	3	3	6	1	104	25.4
Fairfield.....	...	1	4	3	2	5	6	10	14	17	5	3	5	3	3	6	1	88	21.4
Glastonbury.....	1	...	1	...	3	1	3	3	4	3	2	2	3	3	3	...	2	33	15.0
Greenwich.....	7	1	2	3	12	17	24	38	28	16	8	6	7	7	3	6	9	194	30.8
Groton.....	1	3	1	7	14	7	13	4	2	3	3	4	6	5	3	4	3	83	31.9
Hamden.....	1	1	...	3	4	7	9	12	8	6	2	2	2	3	1	2	2	65	19.7
Hartford.....	37	47	54	71	115	179	253	172	129	74	57	55	50	45	57	63	66	1,524	34.1
Killingly.....	...	...	3	6	9	15	6	4	4	1	2	5	1	1	1	3	2	63	24.2
Manchester.....	2	1	4	1	7	17	17	17	8	5	4	2	5	6	2	3	8	109	16.8
Meriden.....	13	9	10	9	30	100	81	44	26	10	13	14	10	11	10	12	13	415	38.0
Middletown.....	14	9	11	13	22	49	60	46	26	24	20	18	10	15	18	24	15	394	42.4
Milford.....	...	4	3	...	1	1	8	4	9	3	1	1	2	2	2	5	3	49	13.2
Naugatuck.....	6	1	2	2	18	29	37	34	12	1	6	1	3	2	3	1	6	164	35.7
New Britain.....	12	9	11	13	32	90	151	117	56	19	10	14	16	26	24	21	15	636	31.2
New Haven.....	37	42	44	44	67	129	204	243	218	127	81	62	55	81	69	83	60	1,646	29.4
New London.....	5	6	16	49	62	65	28	16	10	12	13	15	13	13	12	18	12	365	39.7
New Milford.....	1	...	2	1	...	1	5	7	6	3	1	1	...	...	...	...	1	29	17.1
Norwalk.....	6	5	6	4	12	30	42	43	32	20	19	10	7	15	11	9	10	281	29.0
Norwich.....	12	10	23	33	67	71	36	22	14	14	14	6	9	10	7	14	10	372	37.2
Orange.....	8	5	1	6	10	11	20	23	16	6	6	4	7	9	9	9	13	163	28.6
Plainfield.....	...	...	3	2	4	3	13	4	5	4	3	...	2	1	2	2	2	50	17.8
Plymouth.....	2	1	...	3	3	5	17	11	5	2	2	5	1	...	2	3	3	65	27.1
Putnam.....	...	4	1	6	8	12	20	9	11	6	6	6	4	3	5	3	5	109	37.6
Seymour.....	2	3	1	1	1	9	23	30	9	2	3	1	3	2	1	2	...	93	40.4
Shelton.....	3	5	2	8	12	12	8	5	2	4	5	2	2	2	6	4	3	89	26.7
Southington.....	3	4	...	1	3	7	2	21	13	5	4	3	2	5	6	4	...	89	28.9
Stafford.....	1	2	3	1	2	...	3	3	4	3	...	2	1	1	2	5	1	34	16.2
Stamford.....	8	3	10	11	29	28	47	76	37	26	16	15	16	14	21	16	25	398	27.4
Stonington.....	3	5	7	6	16	14	8	4	...	2	2	3	2	3	4	6	10	95	25.6
Stratford.....	4	3	2	2	5	5	10	11	7	8	8	5	1	3	6	3	1	84	17.5
Torrington.....	3	8	3	3	5	7	18	26	20	17	10	6	9	8	12	16	10	181	23.9
Vernon.....	...	7	2	3	6	19	24	12	8	1	3	...	4	2	2	6	2	101	33.7
Wallingford.....	1	3	2	8	12	20	12	6	3	...	1	2	1	2	2	2	2	79	19.7
Waterbury.....	29	16	22	22	34	137	302	263	134	51	36	24	25	30	41	41	34	1,241	34.8
Watertown.....	1	1	1	1	1	5	15	7	5	...	3	1	2	2	1	2	1	49	22.2
West Hartford.....	1	3	2	4	5	12	5	25	8	4	2	...	3	4	5	1	5	89	34.2
Westport.....	2	...	2	5	...	5	10	6	4	1	2	1	6	8	3	2	...	57	31.6
Winchester.....	2	3	1	1	10	13	22	22	9	6	1	5	...	6	5	1	1	108	32.7
Windham.....	2	3	9	15	36	62	26	16	5	1	2	3	2	...	5	6	7	200	42.6
Windsor.....	2	5	...	1	1	6	2	10	10	5	3	1	3	1	...	...	1	51	22.2
Towns under 5,000.....	54	48	62	76	116	204	203	171	123	84	70	53	61	57	83	74	83	1,622	22.3
Total.....	332	343	392	532	912	1,656	2,105	1,990	1,386	774	571	452	455	497	532	592	537	14,058	28.8
Unknown.....	2	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...

VARIATIONS IN URBAN AND RURAL INCIDENCE

A second relation, clearly brought out by an analysis of our figures is the greater incidence of influenza in large as compared with small communities. The respective rates for each county are shown in table 12.

With the single exception of Tolland County, in which the small towns were severely hit, the rates were in every case higher in the larger communities.

TABLE 12
DEATH RATE (TOTAL) PER 1,000 ON ANNUAL BASIS

County	Large Towns (over 5,000)	Small Towns (under 5,000)
New London.....	35	31
Middlesex.....	39	19
New Haven.....	31	22
Windham.....	32	20
Tolland.....	27	30
Hartford.....	30	20
Fairfield.....	26	18
Litchfield.....	25	20

In certain counties we attempted a closer analysis of actual conditions by dividing some of the smaller towns into groups of a purely agricultural nature and groups in which manufacturing supplements agriculture to some extent.

In New Haven County, for example, the towns of Bethany, East Haven, Madison, Middlebury, North Branford; Oxford, Prospect, Wolcott and Woodbridge are purely agricultural. They had a combined death rate from influenza and pneumonia for the three months of September to November, inclusive, of 9.2 on an annual basis. The towns of Beacons Falls, Branford, Cheshire, Guilford, North Haven and Southbury, in which there are manufacturing plants, had a corresponding rate of 15.6.

In Litchfield County the purely agricultural towns of Bethlehem, Bridgewater, Canaan, Goshen, Harwinton, Kent, Morris, Roxbury, Sharon, Woodbury, Washington and Warren had a combined rate of 6.5. The partly manufacturing towns of Barkhamstead, Litchfield, New Hartford, New Milford, Norfolk, North Canaan, Plymouth, Salisbury, Thomaston, Watertown and Winchester had a rate of 18.3. Similar data for Fairfield County and for a group of towns in the state untouched by a railroad are presented in tables 13 and 14.

It will be noted that the data cited for these smaller towns are based only on influenzal-pneumonia rates up to December 1, and returns for December and January (which have not been analyzed in this way) might show some change in the relative figures, due to slower spread of the disease in rural communities. As a matter of fact, however, a study of the figures for the early months of 1919 shows no such tendency to equalization of rural and urban rates, but rather the contrary. The rate for the entire state for January, 1919, was 19.8, and that for the towns under 5,000 only 17.5.

Dr. Raymond Pearl in his illuminating study "On Certain General Statistical Aspects of the 1918 Epidemic in American Cities,"⁸ has

⁸ Public Health Reports for Aug. 8, 1919.

TABLE 13
DEATH RATES IN FAIRFIELD COUNTY

Agricultural Towns	Population	Deaths
Darien.....	8,198	13
Easton.....	1,272	1
Monroe.....	1,364	4
New Fairfield.....	557	2
Sherman.....	525	1
Weston.....	734	2
Wilton.....	1,848	3
Totals.....	14,498 Death Rate, 7.2 (on annual basis)	26
Manufacturing and Agricultural Towns		
Bethel.....	3 046	4
Brookfield.....	986	1
New Canaan.....	4,852	10
Newtown.....	2,985	0
Redding.....	2,576	3
Ridgefield.....	3,576	16
Shelton.....	8,573	35
Trumbull.....	2,651	4
Westport.....	5,337	21
Totals.....	34,582 Death Rate, 11.6 (on annual basis)	94

TABLE 14
DEATH RATE FROM INFLUENZAL PNEUMONIA IN CONNECTICUT TOWNS UNTOUCHED BY
STEAM RAILROAD

TOWNS	Population	Deaths
North Stonington.....	1,195	2
Voluntown.....	739	4
Salem.....	562	
Ashford.....	833	6
Union.....	345	
Eastford.....	534	2
Woodstock.....	1,955	4
Brooklyn.....	1,930	5
Hebron.....	1,048	
East Haddam.....	2,848	3
Lyme.....	878	
Killingworth.....	526	3
North Branford.....	1,150	1
Easton.....	1,272	1
Glastonbury.....	6,302	11
Marlborough.....	419	
Sharon.....	1,783	4
Goshen.....	599	1
Warren.....	476	
Bethlehem.....	625	
Hartland.....	539	2
Barkhampton.....	811	
Granby.....	1,425	5
Woodbury.....	1,854	3
Totals.....	30,649 Death Rate, 7.2 (on annual basis)	57

concluded that for 39 large cities in the United States there was no correlation between the explosiveness of the influenza outbreak and density of population. Dr. Pearl is, however, dealing with cities which were all sufficiently large to offer practically complete opportunities for contact infection, and it would appear probable from our study that in really rural communities, at least in Connecticut, conditions operated making for a distinctly less heavy incidence than occurred in cities.

An obvious explanation of this difference would be that under the conditions of rural life the opportunities for contact infection are diminished. It is quite possible, however, that the higher rates in the more urban communities may have been due to the age distribution and racial composition of the population, rather than to any factors directly connected with the transmission of the disease.

LOCAL VARIATIONS IN INDIVIDUAL TOWNS

Aside from the effect of exposure to the virulent original infection of the early weeks of the epidemic, and aside from the differences between rural and urban communities in general, there were enormous variations between the severity of the epidemic in individual communities. Returning to our general basis of the death rate from all causes for the last four months of 1918, the towns may be grouped in the following manner:

TABLE 15
DEATH RATE FROM ALL CAUSES

Group 1 Rate under 15	Group 2 Rates 15-19	Group 3 Rates 20-24	Group 4 Rates 25-29
Darien..... 10 Milford..... 13	Glastonbury.... 15 Stafford..... 16 E. Hartford.... 17 Manchester.... 17 New Milford.... 17 Stratford..... 17 Berlin..... 18 Plainfield..... 18	Hamden..... 20 Wallingford.... 20 Fairfield..... 21 Watertown.... 22 Windsor..... 22 Towns under 5,000..... 22 Branford..... 24 Killingly..... 24 Torrington.... 24	Enfield..... 25 Bridgeport.... 26 Bristol..... 26 Stonington.... 26 Danbury..... 27 Plymouth..... 27 Southington... 27 Stamford..... 27 New Haven.... 29 Norwalk..... 29 Orange..... 29 Shelton..... 29
Group 5 Rates 30-34	Group 6 Rates 35-39	Group 7 Rates 40-44	Group 8 Rate over 45
Ansonia..... 31 Greenwich..... 31 New Britain... 31 Groton..... 32 Westport..... 32 Winchester... 33 Hartford..... 34 Vernon..... 34 W. Hartford... 34	Waterbury..... 35 Naugatuck.... 36 Norwich..... 37 Meriden..... 38 Putnam..... 38	New London... 40 Seymour..... 40 Middletown... 42 Windham..... 43	Derby..... 56

The variations are enormous, from towns like Darien and Milford which exhibited death rates that would be low in the absence of any epidemic, to New London, Seymour, Middletown, Windham and Derby with rates two or three times a normal figure.

Certain influences already discussed will help to some extent to explain these differences. Thus, the 15 very low rates are all in fairly small communities. All the rates below 24 are in towns of less than 12,000 population, with the exception of Manchester (19,590), Stratford (14,384) and Fairfield (12,187). On the other hand, of the ten towns with the highest rates (over 34) only 3 (Derby, Seymour and Putnam) had a population of under 12,000. Of these 10 communities which suffered most severely, 4—Waterbury, Naugatuck, Seymour and Derby—are closely grouped in the Naugatuck Valley, and apparently form a single focus of specially virulent infection.

One factor which appeared to affect the severity of the epidemic was proximity in time to the original New London outbreak. In table 16 we have classified the towns according to the week of maximum deaths; and it is apparent that while 10 out of 12 towns which reached their maximum during the first two weeks of October had a total death rate of over 24, not a single one of the 8 towns which showed their maximum in November attained this limit. Again, we have a strong indication that the virus of the epidemic was most virulent or most readily communicable when it first reached the state, and thereafter became gradually attenuated.

The differences between individual towns, like those between local and urban communities, is not reduced but accentuated by later figures. Thus, of the towns which escaped most lightly in the fall, Darien had a total death rate of 20 for January; Milford a rate of 18; Glastonbury a rate of 13; while the rate for New London was 37; for Seymour, 12; for Middletown, 26; for Windham, 18, and for Derby, 20.

Dr. Pearl's researches on the explosiveness of the influenza epidemic in 39 large cities of the United States indicated a distinct but not a high correlation between this factor and distance from the initial focus of the disease—the correlation being -0.348 ± 0.095 . He is inclined, however, in his discussion to minimize somewhat the importance of this relation. Dr. Pearl assumed the primary focus to be Boston, and took as his factor for geographical position the linear distance in miles between Boston and the various other cities studied. It seems somewhat doubtful whether such linear distances constitute a fair measure of the rate of transmission of disease, which depends

so much on the extent of travel between different points and other variable factors. For the group of communities that we have studied in Connecticut, we have compared the severity of the outbreak (not its explosiveness as measured by Pearl) with the week of maximum incidence, and the correlation obtained, based on the data given in table 16 (computations made through the courtesy of Dr. L. I. Dublin) is $r = -0.520 \pm 0.070$, a correlation which we consider distinctly significant.

TABLE 16

RELATION BETWEEN SEVERITY OF THE EPIDEMIC AND DATE OF MAXIMUM INCIDENCE

Death Rate	Period of Maximum Incidence, Week Ending					
	October 5	October 12	October 19	October 26	November 2	November 9
Under 25		Wallingford 20 Killingly.... 24	Manchester 17 Plainfield.. 18 Watertown 22	E. Hartford. 17 New Milford. 17 Stratford.... 17 Hamden..... 20 Torrington.. 24	Darien..... 10 Milford..... 13 Glastonbury 15 Stafford.... 16 Berlin..... 18 Windsor.... 22 Branford.... 24	Fairfield 21
25-34	Stonington.. 26 Groton..... 32	Shelton..... 27 Ansonia..... 31	Enfield.... 25 Bristol.... 26 New Britain 31 Westport.. 32 Winchester 33 Vernon.... 34 Hartford.. 34 Plymouth.. 27	Bridgeport.. 26 Danbury.... 27 New Haven.. 29 Norwalk.... 29 Orange..... 29 Southington 29 Stamford... 27 W. Hartford 34		
Over 34	New London 40	Norwich..... 37 Meriden..... 38 Windham... 43 Derby..... 56	Naugatuck 36 Putnam.... 38 Waterbury 35 Middletown 42	Seymour.... 40		

We have not found the study of the curves of the epidemic particularly significant. Figures 8 and 9 show typical curves for some of the smaller and larger communities, respectively, and are fairly illustrative of a large number we have plotted. Figure 8 is based on deaths from influenza and pneumonia alone; figure 9 on deaths from all causes. The outbreak in a given community generally occupied a period of from 6-8 weeks, and was steep and abrupt in communities which were badly hit; flatter and more gently sloping in those which escaped lightly.

Aside from the two facts mentioned above, that the outbreak was more severe in communities that received the infection early than in those later affected, and that it was on the average more severe in urban than in rural communities, we have found little clear evidence as to the factors associated with variations in local prevalence.

It is possibly significant that cities like New London, Derby, Waterbury and Seymour, which have been overcrowded by war workers, suffered severely, and it seems probable that unsanitary conditions may favor the spread of infection.

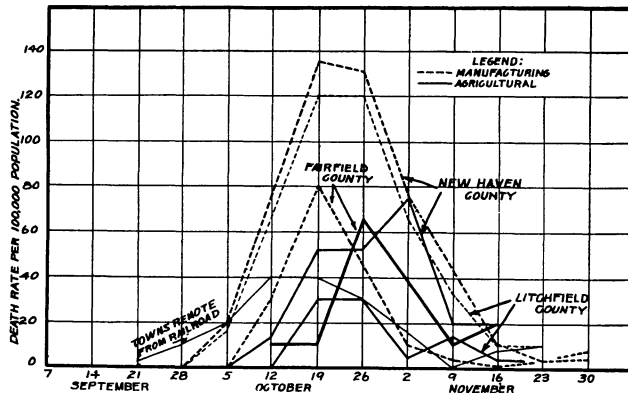


Fig. 8.—Weekly distribution of deaths from influenza and pneumonia in small manufacturing and agricultural communities and in towns remote from the railroad (actual weekly death rate, not on annual basis).

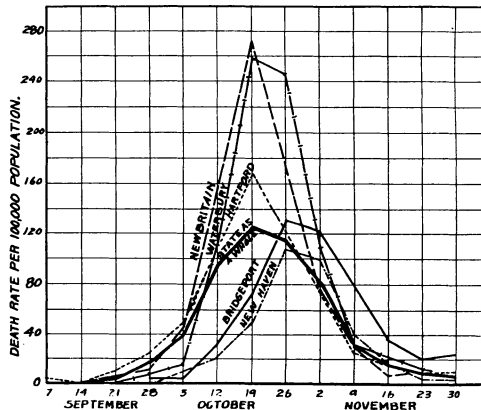


Fig. 9.—Weekly distribution of deaths from influenza and pneumonia in the larger cities of Connecticut compared with the state as a whole (actual weekly death rate, not on annual basis).

It seems quite certain that none of the orthodox methods of combating epidemics applied in Connecticut exerted any appreciable influence on the spread of influenza. The State Department of Health advocated the keeping open of schools under close medical supervision, and of theaters, provided persons who coughed and sneezed were

excluded, and opportunities offered for educational addresses by local health officials. The three largest cities—Bridgeport, Hartford and New Haven—followed this policy, and suffered from death rates near the average for the state, lower than the rates which prevailed in cities like New London and Waterbury, which closed their schools. No deductions can be drawn from this fact, however, because the closing of the schools in most cases was forced because the outbreak was so severe.

RELATION BETWEEN THE SEVERITY OF THE INFLUENZA EPIDEMIC AND
THE DEATH RATE FOR PREVIOUS YEARS IN CONNECTICUT
AND IN CERTAIN LARGE CITIES OF THE
UNITED STATES

We have devoted considerable time to a study of possible relations between the incidence of influenza in various towns in 1890-92 and during the present outbreak, but without very tangible conclusions. We also compared the incidence of pneumonia for the period, 1891-1916, with the incidence of the 1918 epidemic, but without striking results. Torrington has had a consistently low pneumonia record (102 was the average pneumonia death rate per 100,000 population for the period 1891-1916), and escaped lightly in 1918. Waterbury and Middletown (pneumonia rates 170 and 203, respectively) have had uniformly high rates (largely due to the presence of hospitals), and suffered severely in 1918. On the other hand, New Britain, Danbury and Norwalk, which had shown low pneumonia rates (134, 129 and 125, respectively) experienced a moderate incidence of influenza in 1918; while Bridgeport, Hartford, New Haven and Stamford (all hospital cities) which had shown consistently high rates (169, 203, 172 and 172, respectively), also suffered but moderately in 1918. Meriden with a good past record (129), and New London, Norwich and Windham with moderate pneumonia records (152, 144 and 137, respectively), had high death rates in 1918.

A study of the relation between the 1918 mortality and the general death rate from all causes in previous years proved more significant. We obtained from Mr. Balfe the annual death rates for the 49 large towns for 1915, 1916, and 1917, and averaged them to obtain the figures presented in table 17. Through the courtesy of Dr. L. I. Dublin, the correlation was calculated between these figures and the death rates from all causes for the period September-December, 1918,

as given in the last column of table 11. The correlation worked out as follows: $r = +0.627 \pm 0.058$, which from the statistical standpoint is, of course, a highly significant figure. It might be suggested, since we dealt only with death rates from all causes, that such a correlation would naturally be expected between the death rates in a community during successive years. When, however, it is remembered that 60 per cent. of all the deaths in Connecticut during the last four months of 1918 were due to influenza and pneumonia (see table 4), it seems evident that in order to yield such a high coefficient of correlation the

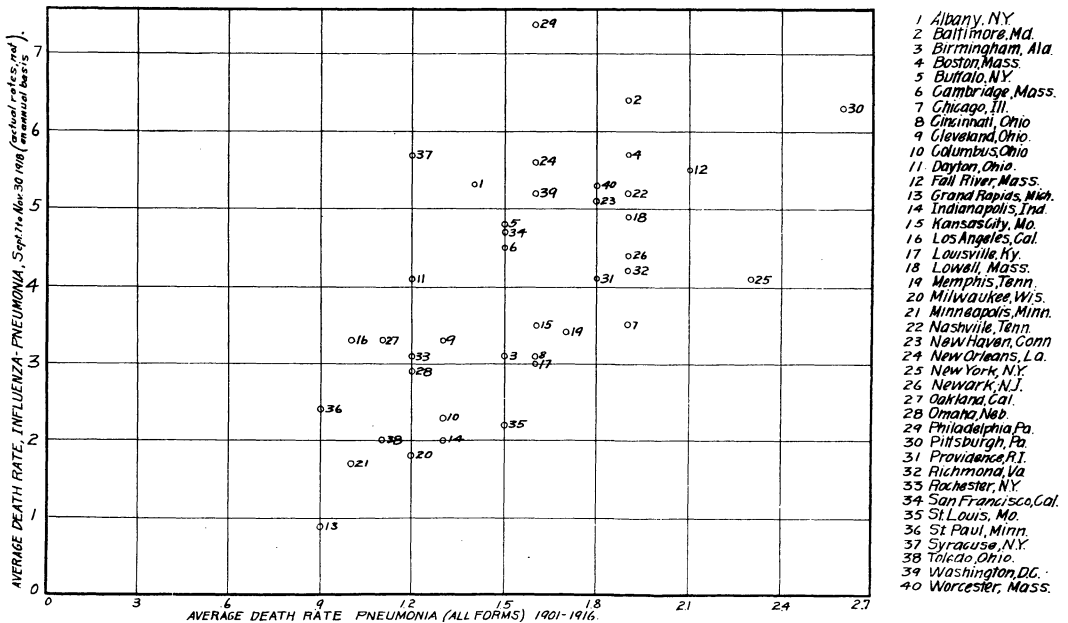


Fig. 10.—Relation of pneumonia death rate, 1901-1916, to influenza death rate, 1918, in certain large cities of the United States.

course of the influenza epidemic in 1918 must to a considerable extent have followed the variations in total death rate normal for the various communities affected.

Dr. Pearl, in the paper previously cited, has shown that for the larger cities of the country there were similar high correlations between his index of epidemicity of influenza and the 1916 death rates from all causes, from pulmonary tuberculosis, from organic heart disease and from acute nephritis and Bright's disease, while correlations with 1916 influenza and pneumonia were of lesser magnitude.

Before Dr. Pearl's report was published we had ourselves begun a tentative study of the relation between 1918 influenza-pneumonia and the death rate from pneumonia and other causes in the larger cities of the United States.

TABLE 17
AVERAGE DEATH RATE FROM ALL CAUSES, 1915-1917

Towns	Average Death Rate from All Causes, 1915-1917	Towns	Average Death Rate from All Causes, 1915-1917
Ansonia.....	13.9	New Milford.....	14.2
Berlin.....	9.0	Norwalk.....	14.6
Branford.....	12.2	Norwich.....	19.6
Bridgeport.....	15.7	Orange.....	12.4
Bristol.....	11.0	Plainfield.....	12.3
Danbury.....	15.6	Plymouth.....	9.0
Darien.....	14.2	Putnam.....	16.8
Derby.....	22.3	Seymour.....	13.2
East Hartford.....	10.6	Shelton.....	20.9
Enfield.....	13.7	Southington.....	12.8
Fairfield.....	12.9	Stafford.....	12.8
Glastonbury.....	9.7	Stamford.....	15.5
Greenwich.....	15.6	Stonington.....	13.6
Groton.....	14.8	Stratford.....	12.2
Hamden.....	11.9	Torrington.....	10.7
Hartford.....	15.8	Vernon.....	12.6
Killingly.....	15.0	Wallingford.....	12.0
Manchester.....	9.2	Waterbury.....	14.6
Meriden.....	17.2	Watertown.....	12.6
Middletown.....	23.1	West Hartford.....	20.8
Milford.....	15.8	Westport.....	18.2
Naugatuck.....	11.0	Winchester.....	17.2
New Britain.....	12.2	Windham.....	19.7
New Haven.....	16.3	Windsor.....	12.9
New London.....	18.2		

For 1918 data we used the number of deaths per 1,000 from influenza and pneumonia for the 12-week period from September 7 to November 30 as presented in a special summary of the Weekly Health Index of the U. S. Census Bureau. For early data we used the death rates from pneumonia (all forms) and from all causes. The fundamental data utilized in this study are presented in table 18, and the general relation between the pneumonia rates for the previous sixteen years and the influenzal-pneumonia rates for 1918 is brought out in figure 10. It is evident that there is a rather definite correlation indicated, the cities which have been characterized by a high pneumonia rate in the past being in general precisely the cities which suffered most severely in the 1918 outbreak. At this stage of the analysis we were inclined to suspect that the presence of particularly virulent types of pneumonia organisms in certain sections of the country might have played an important part in determining the fatality experienced in the influenza epidemic of 1918.

A comparison of the total death rates from all causes for the period 1901-16 with the influenzal-pneumonia death rate for the epidemic months of 1918, showed that such an assumption would be unwarranted. Figure 11 indicates that the correlation of the severity of the influenza epidemic with *total* death rates in the past was as close as with pneumonia death rates.

This correlation between 1918 influenza and previous mortality from other causes has been demonstrated by Dr. Pearl with a clearness

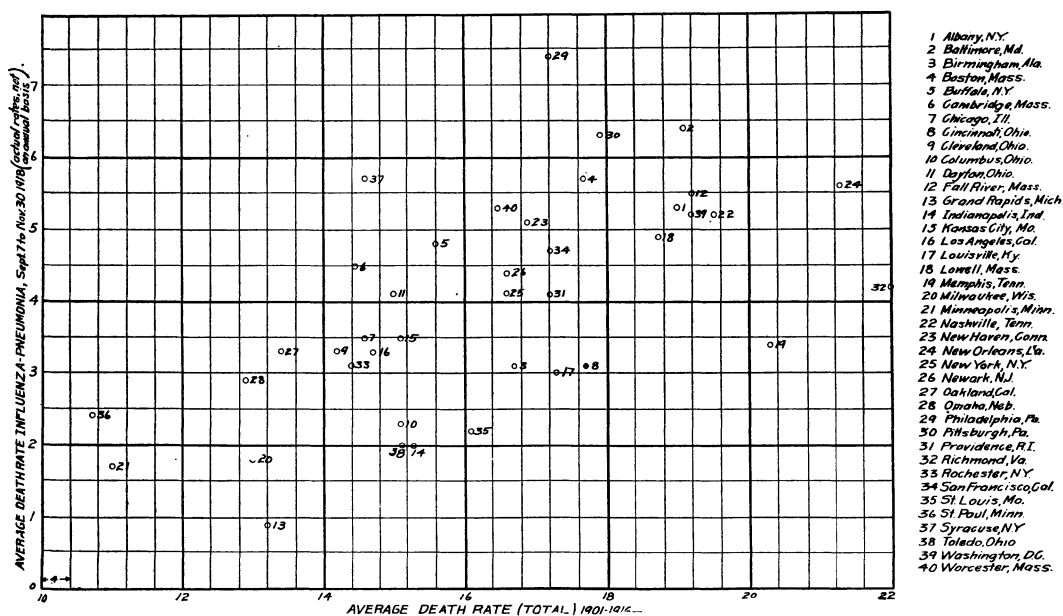


Fig. 11.—Relation of total death rate, 1901-1916, to influenza death rate, 1918, in certain large cities of the United States.

that made it seem unnecessary for us to carry out any detailed mathematical study of our own data. That the correlations found by him between the epidemicity of influenza in 1918 and the death rates from all causes, from pulmonary tuberculosis, organic heart disease and acute nephritis and Bright's disease, is a highly significant statistical correlation is quite certain. The interpretation of its significance is a much more complex matter and in this connection we have thought the graphic presentations contained in figures 10 and 11 worthy of brief consideration.

TABLE 18
AVERAGE TOTAL, PNEUMONIA, AND INFLUENZAL-PNEUMONIA DEATH RATES PER 1,000
FOR LARGE AMERICAN CITIES

Cities	Average Death Rate (Total) 1901-1916	Average Death Rate Pneumonia (All Forms) 1901-1916	Average Death Rate Influenzal- Pneumonia Sept. 7- Nov. 30, 1918 (Actual Rates, Not on Annual Basis)
Albany, N. Y.	19.0	1.4	5.3
Baltimore, Md.	19.1	1.9	6.4
Birmingham, Ala.*	16.7	1.5	3.1
Boston, Mass.	17.7	1.9	5.7
Buffalo, N. Y.	15.6	1.5	4.8
Cambridge, Mass.	14.5	1.5	4.5
Chicago, Ill.	14.6	1.9	3.5
Cincinnati, O.	17.7	1.6	3.1
Cleveland, O.	14.2	1.3	3.3
Columbus, O.	15.1	1.3	2.3
Dayton, O.	15.0	1.2	4.1
Fall River, Mass.	19.2	2.1	5.5
Grand Rapids, Mich.	13.2	0.9	0.9
Indianapolis, Ind.	15.3	1.3	2.0
Kansas City, Mo.	15.1	1.6	3.5
Los Angeles, Calif.	14.7	1.0	3.3
Louisville, Ky.	17.3	1.6	3.0
Lowell, Mass.	18.7	1.9	4.9
Memphis, Tenn.	20.3	1.7	3.4
Milwaukee, Wis.	13.0	1.2	1.8
Minneapolis, Minn.	11.0	1.0	1.7
Nashville, Tenn.	19.5	1.9	5.2
New Haven, Conn.	16.9	1.8	5.1
New Orleans, La.	21.3	1.6	5.6
New York, N. Y.	16.6	2.3	4.1
Newark, N. J.	16.6	1.9	4.4
Oakland, Calif.	13.4	1.1	3.3
Omaha, Neb.	12.9	1.2	2.9
Philadelphia, Pa.	17.2	1.6	7.4
Pittsburgh, Pa.	17.9	2.6	6.3
Providence, R. I.	17.2	1.8	4.1
Richmond, Va.	22.0	1.9	4.2
Rochester, N. Y.	14.4	1.2	3.1
San Francisco, Calif.	17.2	1.5	4.7
St. Louis, Mo.	16.1	1.5	2.2
St. Paul, Minn.	10.7	0.9	2.4
Syracuse, N. Y.	14.6	1.2	5.7
Toledo, O.	15.1	1.1	2.0
Washington, D. C.	19.2	1.6	5.2
Worcester, Mass.	16.5	1.8	5.3

* Death rates for Birmingham are the average for six years only, 1910-1916.

Granting that there was a distinct correlation, such as Pearl has demonstrated, between the epidemicity of influenza in various communities and the death rate from certain organic disorders in previous years, the phenomenon might in the first place be the result of a direct connection between the two correlated factors. In other words, the rapid explosive spread of the epidemic in Pearl's case, and the high mortality from influenza in the case of our Connecticut figures, may have been the result of weaknesses in the population due to high incidence of organic diseases and tuberculosis in earlier years. It is

equally possible from a statistical standpoint, and inherently more probable, that the correlation is an indirect one, due to the relation between each of the factors studied and one or more underlying conditions affecting both. Thus the death rates from organic diseases and tuberculosis in previous years, and the incidence of influenza mortality in 1918, may both have been due to peculiarities in

- a. Age distribution of the population.
- b. Race distribution of the population.
- c. Social and economic conditions in the various cities studied.

Or finally, it may be possible that the high rate from tuberculosis and organic disease in 1916 was due to the factors enumerated above and that the high incidence of influenza was due chiefly to proximity to the original focus of infection—the correlation being due merely to the accidental circumstance that the concentration of foreign race stocks living under poor economic conditions, and the original point of introduction of the influenza epidemic, both happened to be on the Atlantic seaboard.

Dr. Pearl has dealt with certain of these questions by calculating the correlation between his influenza epidemicity and the 1916 death rate from tuberculosis, organic heart disease and Bright's disease and nephritis—after correcting for age distribution and linear distance from Boston. He finds higher correlations after correction than before. The actual significance of such corrections, when made at the same time, as Pearl has made them, is, however, very difficult to interpret. The age distribution favorable to influenza is also favorable to tuberculosis, but unfavorable to organic heart disease and nephritis; while the factor of race, with its accidental relationship to geographical position, is almost impossible to evaluate in this way.

The broad fact, as indicated graphically in figures 10 and 11, would seem to be that eastern and southern cities with industrial populations, largely of Irish and Latin and Slavic stock, show high death rates from all causes, as well as from influenza and pneumonia, while western and middle western cities, with in general better living conditions and less Irish and Latin and Slavic stock, show lower death rates. In part, the greater severity of the influenza epidemic in the east may be attributed to the more unfavorable living condition in industrial communities and the higher proportion of Italian race stocks which we have shown favored high mortality in Connecticut. It is obvious, however, that the correlation indicated may in part be an accidental

one. The low death rates characteristic of western cities in the past must no doubt be attributed to social and economic and racial factors; but the low influenza rates exhibited by the same cities in 1918 may in part be the result of the fact that they were exposed to the epidemic at a later period when, if the conclusions drawn in Connecticut are justified, it may probably have suffered from a natural decline in virulence or communicability.

SUMMARY AND CONCLUSIONS

The 1918 epidemic of influenza began in Connecticut with cases at the Naval Hospital in New London about September 1. From the naval base the disease spread rapidly to the civilian population. Other independent foci developed later at various points throughout the state, the source in several instances being the military population of Camp Devens, Mass.

The epidemic as a state-wide phenomenon lasted from September 14 to November 30, with recrudescences in December and January. Its height was reached between October 12 and October 26.

The epidemic cost the state about 7,700 lives, and was by far the most serious sanitary calamity from which Connecticut has ever suffered. The total death rate for the year was 19.4 per 1,000, a rate previously reached only in the earlier influenza epidemic year of 1892. The monthly rate for October was 63.9 (deaths per 1,000 population on an annual basis), double the rate for the worst single month in 1892.

It seems probable, from such imperfect data as are available, that the case rate in affected communities varied between 200 and 400 cases per 1,000 population, and the fatality rate between 2 and 4 deaths per 100 cases. Estimating on a basis of excess total deaths as compared with the corresponding months of 1917, the average excess mortality due to the epidemic for the state as a whole would be about 5.5 per 1,000.

The rapid spread of the disease throughout the state and the fact that quarantine completely protected isolated groups of individuals (so long as the quarantine was rigidly maintained) indicates clearly that it was transmitted by human contact, perhaps supplemented in certain cases by the use of infected food and utensils.

The mortality from the epidemic was proportionately higher among males than among females, and it was proportionately very much higher at ages under 5 years and at ages from 20-40 than at other

periods of life. It seems somewhat doubtful whether the lower mortality in later adult life can be attributed to immunity acquired in the 1892 epidemic, since immunity due to this cause should have manifested itself in the age-period from 30-40 which, as a matter of fact, showed practically the same proportionate rate as the decade from 20-30.

The mortality was relatively low among persons of native Irish, English and German mother nativity. It was relatively high among persons of Canadian, Russian, Austrian and Polish mother nativity, and exceedingly high among persons of Italian mother nativity. The Italian race stock contributed nearly double its normal proportion to the state death roll during the epidemic period. The excessive incidence among the Latin and Slavic races mentioned (the Canadians being largely of French race stock) may in part be attributed to the age composition of these racial elements and perhaps to overcrowding and general poor economic conditions. This can hardly be sufficient, however, to account for such enormous differences as appear in the case of the Italians.

The mortality from the epidemic was lower in rural than in urban communities, lower in agricultural than in manufacturing communities, and very low in a group of small towns remote from any railroad.

The mortality was in general highest in those communities which were affected earliest. As the wave of infection passed westward and northward the mortality became less, strongly suggesting a progressive decrease in virulence or in communicability. The correlation between the mortality from all causes for September-December, 1918, and the week of maximum incidence of the epidemic was -0.520 ± 0.070 .

The severity of the epidemic varied greatly in different communities. These variations are partly, but only partly, to be explained by the relations discussed under the foregoing conclusions. There is no evidence that variations in administrative procedure, such as the closing of schools, exerted any influence on the spread or the severity of the disease.

The severity of the epidemic in different communities in Connecticut showed no clear correlation with the severity of the 1892 epidemic or with the prevalence of ordinary pneumonias since that epidemic. The mortality from all causes for September-December, 1918 (of which influenza-pneumonia made up 60%), was however closely correlated with the average mortality for 1915-1917, the figure being

$+ 0.627 \pm 0.058$. A study of the census statistics for the larger cities of the United States as a whole showed a very definite relation between the severity of the 1918 influenza epidemic and both the pneumonia death rate and the total death rate for the sixteen years preceding. The relation is in general a geographical one, the eastern and south-eastern cities showing high death rates, the middle-western and western cities low death rates in each case. The higher pneumonia rates and total death rates in the eastern section may reasonably be attributed to unfavorable economic conditions associated with industrial life and presence of certain foreign race stocks always characterized by a high death rate. Whether the greater severity of the influenza epidemic in these same cities was due to the same causes or to a gradual loss of communicability or virulence as the infection passed westward from its point of introduction seems uncertain. In any case there are differences between individual cities (such as New York and Philadelphia) which cannot be explained on either assumption.